Natural Conditions Assessment for Low pH

Herring Creek and Tributaries

Caroline County and King William County, Virginia

Submitted by

Virginia Department of Environmental Quality

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Executive Summary

This report assesses whether low pH in the Herring Creek watershed is due to natural conditions, or whether a Total Maximum Daily Load (TMDL) must be developed because of anthropogenic impacts. Herring Creek is located in Caroline County and King William County, VA in the York River Basin (USGS Hydrologic Unit Code 02080105). The TMDL waterbody identification code (WBID, Virginia Hydrologic Unit) for Herring Creek is VAN-F21R-01.

According to the National Hydrography Dataset (NHD), which is based on the content of the USGS 1:100,000-scale data, there are approximately 57.87 total stream miles in the Herring Creek watershed. The impaired segment, VAN-F21R_HER01B02, begins at the confluence of Herring Creek with Dorrell Creek and continues downstream until the start of Herring Creek Millpond[1]. Monitoring for this segment occurs at the Virginia Department of Environmental Quality (DEQ) monitoring station (8-HER005.12) at the Route 609 bridge crossing.

A portion of Herring Creek was first recognized as impaired for the aquatic life use, based on the pH parameter, in 2002. Sampling data showed that 19 of 26 samples (73.1%) were below the lower range (6.0 SU) of the pH water quality criteria for Class III waters as established in 9 VAC 25-260-50 of the Virginia Water Quality Standards (**Figure E-1**). Segment VAN-F21R_HER01B02 was listed in Attachment B (Plaintiff's list of waters) of the 1999 Consent Decree, as identified in the American Canoe Association and the American Littoral Society vs. the United States Environmental Protection Agency decision. Additional monitoring demonstrated that there was enough evidence to support listing of this segment, facilitating the inclusion of the segment in Attachment C (Plaintiff's list of waters that were added to the 303(d) list in 2002) for pH. Because of the segment's inclusion on the Impaired Waters list, a TMDL study, initiated to identify and addressing the source(s) of the pH impairment, is required.

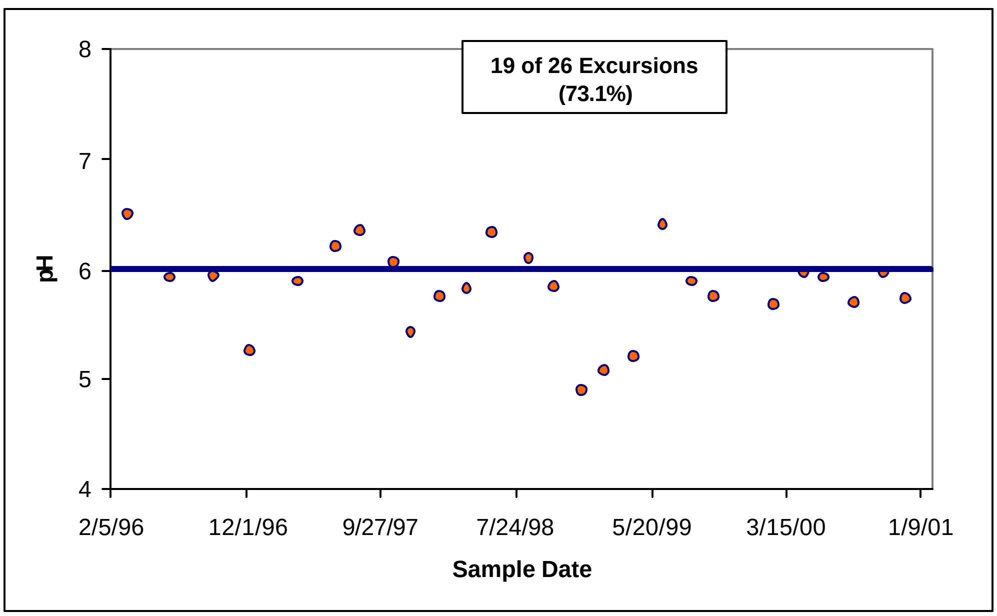


Figure E-1: pH Values for Herring Creek at Route 609 (8-HER005.12) during the 2002 Assessment Window.

*1. The segments noted above as impaired for the pH parameter in the 2006 Integrated Assessment have descriptions referring to the Herring Creek Millpond. The pond, based on aerial photography, extended approximately 0.83 rivermiles along Herring Creek. While collecting physical observations and habitat information for this Natural Conditions Assessment of Herring Creek, it was discovered that Herring Creek Millpond has been drained (**See Figure 12**). Currently, Herring Creek extends* *from the confluence with Dorrell Creek until the confluence with the Mattaponi River solely as a river. The contiguous riverine segments are reflected in this Natural Conditions Assessment and a correction will be made for future Integrated Assessments.*

During the 2004 and 2006 assessment periods, sufficient excursions of the pH standard at station 8-HER005.12 have demonstrated that the segment is not supporting the aquatic life use. Between 1998 and 2002, sampling events showed that 15 of 19 samples (78.9%) were below the lower range (6.0 SU) of the pH water quality criteria for Class III waters as established in 9 VAC 25-260-50 of the Virginia Water Quality Standards. The data for the 2006 assessment window show that 10 of 14 samples (71.4%) were below the lower range of the pH water quality criteria.

A segment first sampled during the 2006 assessment window, VAN-F21R_HER01A06, extends from the outlet of Herring Creek Millpond and continues downstream until the confluence with the Mattaponi River. The data for the 2006 assessment window show that two of six samples (33.3%) were below the lower range of the pH water quality criteria. Samples for this segment were collected at DEQ ambient station 8-HER000.33, at the Route 600 bridge crossing.

According to Virginia Water Quality Standards (9 VAC 25-260-10A), "All state waters are designated for the following uses: recreational uses (e.g., swimming and boating); the propagation and growth of a balanced indigenous population of aquatic life, including game fish, which might be reasonably expected to inhabit them; wildlife; and the production of edible and marketable natural resources (e.g., fish and shellfish)."

As indicated above, Herring Creek must support all designated uses by meeting all applicable water quality criteria. Herring Creek has been assessed as not supporting the aquatic life use due to exceedances of the pH criteria that are designed to protect aquatic life in Class III waters. In an effort to determine if Herring Creek can be reclassified as Class VII (Swamp Waters), this document follows the guidance established by the Virginia Department of Environmental Quality's Procedure for Natural Condition Assessment of Low pH and Low DO in Virginia Streams, prepared in October 2004 and submitted to the EPA on November 30, 2004.

The level of acidity as registered by pH in a water body is determined by a balance between organic acids produced by decay of vegetative material, and buffering capacity. Conditions in a stream that would typically be associated with naturally low pH include slow-moving, ripple-less waters or wetlands where the decay of organic matter produces organic acids. These situations can be compounded by anthropogenic activities that contribute excessive nutrients or readily available organic matter to these systems. The general approach to determine if DO and pH impairments in streams are due to natural conditions is to assess a series of water quality and hydrologic criteria to determine the likelihood of an anthropogenic source. A logical 4-step process for identifying natural conditions that result in low DO and/or pH levels and for determining the likelihood of anthropogenic impacts that will exacerbate the natural condition is described below.

Step 1. Determine slope and appearance.
Step 2. Determine nutrient levels.
Step 3. Determine degree of seasonal fluctuation (for DO only).
Step 4. Determine anthropogenic impacts.

In order to obtain flow information for Herring Creek, USGS Station (01674500) on the Mattaponi River, near Beulahville, VA, had to be used because there were no USGS surface water monitoring stations on Herring Creek. The Virginia Water Quality Standards (9 VAC 25-260-50) state that the water quality criteria do not apply below the lowest flow averaged arithmetic mean over a period of seven consecutive days that can be statistically expected to occur once every 10 climatic years (a climactic year begins April 1 and ends March 31). If any of the samples collected on Herring Creek were taken on a day when the flow was below the 7Q10 flow at the closest downstream station, then that data is not applicable. No pH sampling events taken along Herring Creek occurred while hydraulic conditions were below 7Q10 flow at the reference station on the Mattaponi River (DEQ monitoring station 8-MPN054.17), so all the data was considered.

The slope of Herring Creek from its headwaters to the confluence with the Mattaponi River is 0.17%, which is considered a low slope. There are large inputs of decaying vegetation into Herring Creek from the adjacent swampy areas, oxbows, and other areas of forested land with heavy tree canopy throughout the watershed. This decaying vegetation produces acids which in turn can lead to lower pH values. Herring Creek also exhibits low nutrient concentrations below national background levels in streams from undeveloped areas. These levels of nutrients are not indicative of human impact. The Residential / Commercial land use (approximately 0.5% of the watershed) most likely has no pH effect on streams in the watershed. The watershed is predominately forested (approximately 77%).

There is one individual VPDES permit (VA0023329) in the Herring Creek watershed which is held by the Virginia Department of Corrections for the Caroline County Correctional Unit 2 Sewage Treatment Plant. This facility discharges into an unnamed tributary to Herring Creek, which then feeds into the mainstem of Herring Creek just downstream of the Route 677 bridge crossing. This unnamed tributary joins Herring Creek upstream of the DEQ monitoring station 8-HER005.12. Discharges from the facility have a permitted pH limit of 6.0 - 9.0 SU. This point source most likely has no effect on the low pH in Herring Creek.

The predominant soil type immediately adjacent to Reedy Creek is classified as either a low slope Bibb-Chastain complex or low slope Bill-Kinston soils. These soil types, which cover 1.10% and 8.32% of the Herring Creek watershed, respectively, are hydric, poorly drained, frequently flooded, and possess moderate organic content.

There is not a close correlation between precipitation amounts and field pH at DEQ ambient water quality monitoring stations. The only discernable pattern has been a general negative correlation of precipitation to pH and the majority of r-values were well below 0.5, which does not indicate a close correlation between the variables. However the extent to which stream pH is decreased by acid deposition cannot be conclusively determined.

Three named tributaries to Herring Creek, Dorrell Creek, Fork Bridge Creek, and Millpond Creek, were also evaluated to determine if they should be classified as swamp waters. While there was no DEQ monitoring data for these streams, they were evaluated using visual inspections and low slope determinations. The slopes of all three tributaries were found to be below 0.50%. Field observations of the three tributaries revealed stagnant to relatively slow moving water, which varied in color from light brown to nearly black. The streams are located in highly forested areas and often contained aquatic vegetation, such as marshy grasses. Although a chemical analysis of the nutrient levels in these tributaries is not possible, due to lack of monitoring events along these streams, the low slopes and physical properties of Dorrell Creek, Fork Bridge Creek, and Millpond Creek suggest that these named tributaries to Herring Creek should be reclassified as swamp waters, along with the mainstem Herring Creek.

Based on available information, a change in the water quality standards classification to Class VII Swamp Waters due to natural conditions, rather than a TMDL, is indicated for Herring Creek from its headwaters at rivermile 17.2 downstream to the confluence with the Mattaponi River, as well as for three named tributaries; Dorrell Creek, Fork Bridge Creek, and Millpond Creek. If there is a 305(b)/303(d) assessment prior to the reclassification, Herring Creek and its named tributaries will be assessed as Category 4C, “Impaired due to natural condition, no TMDL needed.”

DEQ performed the assessment of the Herring Creek low pH natural condition in lieu of a TMDL. Therefore neither a TMDL Technical Advisory Committee (TAC) meeting nor a public meeting was held. Public participation will occur during the next water quality standards triennial review process.

1. Introduction

A portion of Herring Creek was initially listed as impaired for the aquatic life use, based on the pH parameter, in 2002. The impaired segment, VAN-F21R_HER01B02, begins at the confluence of Herring Creek with Dorrell Creek and continues downstream until the start of Herring Creek Millpond. Monitoring for this segment occurred at the Virginia Department of Environmental Quality (DEQ) monitoring station (8-HER005.12) at the Route 609 bridge crossing. Segment VAN-F21R_HER01B02 was listed in Attachment B (Plaintiff's list of waters) of the 1999 Consent Decree, as identified in the American Canoe Association and the American Littoral Society vs. the United States Environmental Protection Agency decision. Additional monitoring demonstrated that there was enough evidence to support listing of this segment, facilitating the inclusion of the segment in Attachment C (Plaintiff's list of waters that were added to the 303(d) list in 2002) for pH. Because of the segment's inclusion on the Impaired Waters list, a TMDL study, initiated to identify and addressing the source(s) of the pH impairment, is required.

Sampling data from the 2002 Assessment showed that 19 of 26 samples (73.1%) were below the lower range (6.0 SU) of the pH water quality criteria for Class III waters as established in 9 VAC 25-260-50 of the Virginia Water Quality Standards. During the 2004 and 2006 assessment periods, sufficient excursions of the pH standard have demonstrated that the segment is not supporting the aquatic life use. Between 1998 and 2002, sampling events at station 8-HER005.12 showed that 15 of 19 samples (78.9%) were below the lower range (6.0 SU) of the pH water quality criteria. The data for the 2006 assessment window show that 10 of 14 samples (71.4%) were below the lower range of the pH water quality criteria.

A segment first sampled during the 2006 assessment window, VAN-F21R_HER01A06, extends from the outlet of Herring Creek Millpond and continues downstream until the confluence with the Mattaponi River. The data for the 2006 assessment window show that two of six samples (33.3%) were below the lower range of the pH water quality criteria. Samples for this segment were collected at DEQ ambient station 8-HER000.33, at the Route 600 bridge crossing.

2. Physical Setting

2.1. Listed Water Bodies

Herring Creek is located in Caroline County and King William County, VA in the York River Basin (USGS Hydrologic Unit Code 02080105). The TMDL waterbody identification code (WBID, Virginia Hydrologic Unit) for Herring Creek is VAN-F21R-01. According to the National Hydrography Dataset (NHD), which is based on the content of the USGS 1:100,000-scale data, there are approximately 57.87 total stream miles in the Herring Creek watershed. The impaired segments, VAN-F21R_HER01A06 and VAN-F21R_HER01B02, begin at the confluence of Herring Creek with Dorrell Creek and extend 6.20 rivermiles downstream to the confluence with the Mattaponi River (**Figure 1**). Monitoring for these segments occurred at ambient stations 8-HER000.33, at the Route 600 crossing, and 8-HER005.12, at the Route 609 crossing.

Segment VAN-F21R_HER01B02 was also found to be not supporting the recreation use, as the segment was first listed for a fecal coliform bacteria impairment in 2002 and demonstrated sufficient bacteria exceedances (two excursions in eight sampling events) during the 2006 Integrated Assessment window to remain impaired for the recreation use. Exceedances of the risk-based fish tissue screening value (TSV) for mercury in fish tissue were recorded in five species of fish (bluegill sunfish, chain pickerel, flier sunfish, largemouth bass, and yellow bullhead catfish) during 2003 sampling and are noted by an observed effect for the fish consumption use.

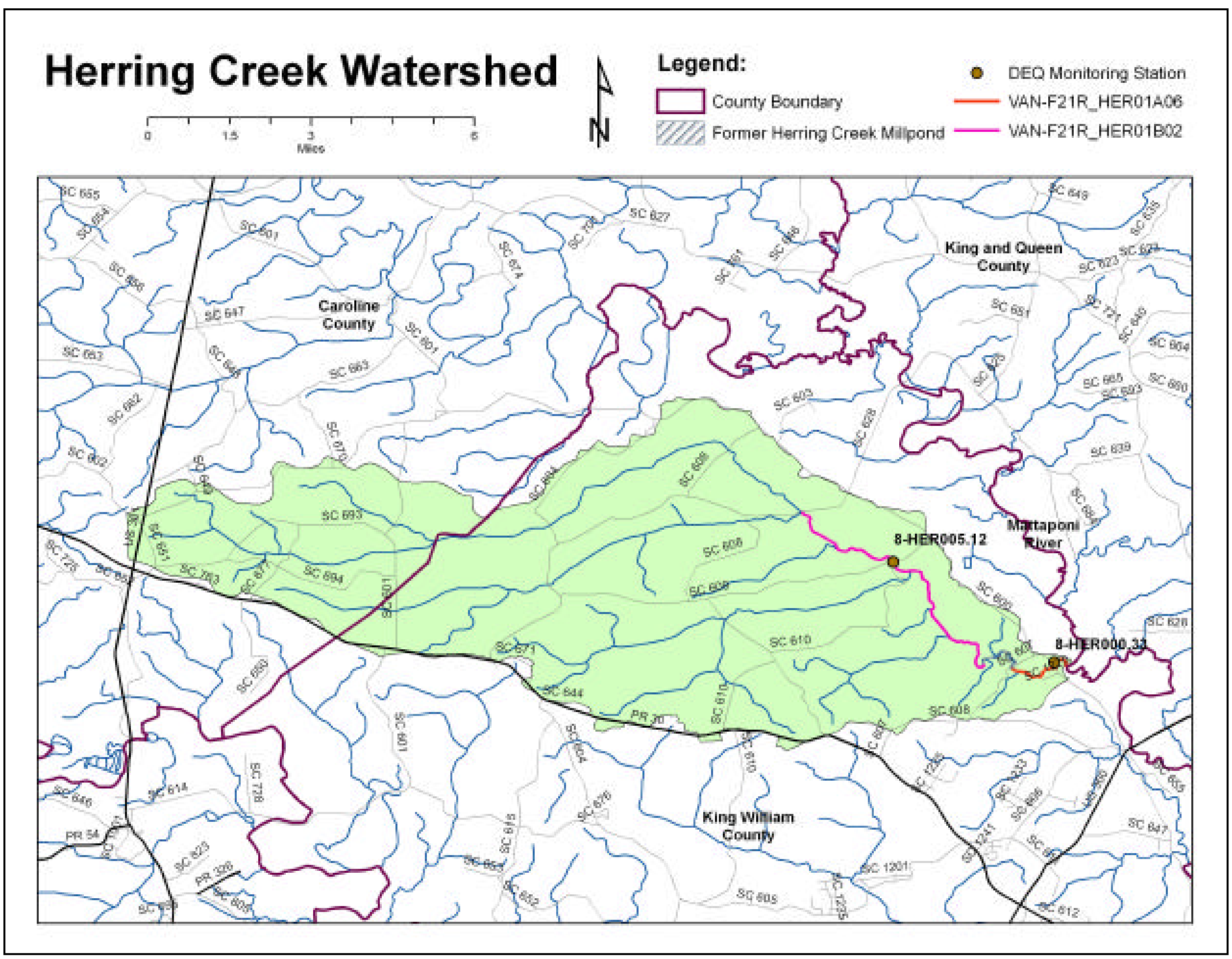


Figure 1. Map of the Herring Creek Study Area.

2.2. Watershed

2.2.1. General Description

Herring Creek, along with its unnamed tributaries, flows through Caroline County and King William County, Virginia. It is approximately 17.2 miles long and flows eastward from its headwaters in the southern part of Caroline County, to its confluence with the Mattaponi River (along the border of King William County and King and Queen County). The watershed has an area of approximately 47.2 square miles. There are no gaging stations on Herring Creek or any of its tributaries.

2.2.2. Geology, Land Use, Climate

Geology and Soils

Herring Creek is in the Atlantic Coastal Plain physiographic region. As described by the Virginia Department of Mines, Minerals, and Energy, the Atlantic Coastal Plain is the easternmost of Virginia's physiographic provinces. The Atlantic Coastal Plain extends from New Jersey to Florida, and includes all of Virginia east of the Fall Line. The Fall Line is the easternmost extent of rocky, river rapids, the point at which east-flowing rivers cross from the hard, igneous and metamorphic rocks of the Piedmont to the relatively soft, unconsolidated strata of the Coastal Plain. The Coastal Plain is underlain by layers of Cretaceous and younger clay, sand, and gravel that dip gently eastward. These layers were deposited by rivers carrying sediment from the eroding Appalachian Mountains to the west.

Table 1. Soil Types in the Herring Creek Watershed.

Map Unit Code:	Soil Type:	Percentage of Watershed:
32	Remlik and Nevarc soils (15-60% slope)	13.31
35	Slagle fine sandy loam (0-2% slope)	12.62
17	Kempsville sandy loam (2-6% slope)	9.83
12	Emporia fine sandy loam (2-6% slope)	9.28
31	Remlik and Nevarc soils (6-15% slope)	8.69
4	Bibb and Kinston soils (0-2% slope)	8.32
36	Slagle fine sandy loam (2-6% slope)	7.10
2	Bama sandy loam (2-6% slope)	4.30
19	Kempsville-Emporia complex (2-6% slope)	4.29
41	Suffolk and Rumford soils (2-6% slope)	3.70
37	Slage-Kempsville complex (2-15% slope)	2.54
18	Kempsville-Emporia complex (0-2% slope)	1.46
15	Eunola sandy loam (2-6% slope)	1.38
21	Kempsville-Emporia-Remlik complex (15-50% slope)	1.17
10	Daleville silt loam (0-2% slope)	1.14
3	Bibb-Chastain complex (0-2% slope)	1.10
14	Eunola sandy loam (0-2% slope)	0.95
45	Tomotley fine sandy loam (0-2% slope)	0.88
30	Pactolus loamy sand (0-2% slope)	0.86
1	Altavista fine sandy loam (0-2% slope)	0.79
44	Tarboro sand (15-50% slope)	0.76
43	Tarboro sand (6-15% slope)	0.67
26	Myatt-Slagle complex (0-2% slope)	0.63
13	Eulonia fine sandy loam (2-6% slope)	0.55

34	Seabrook loamy fine sand (0-2% slope)	0.46
9	Conetoe loamy fine sand (0-4% slope)	0.38
Map Unit Code:	**Soil Type:**	**Percentage of Watershed:**
W	Water	0.37
39	State fine sandy loam (2-6% slope)	0.35
27	Nansemond loamy fine sand (0-2% slope)	0.32
33	Roanoke silt loam (0-2% slope)	0.25
42	Tarboro sand (0-6% slope)	0.24
20	Kempsville-Emporia complex (6-10% slope)	0.21
11	Emporia fine sandy loam (0-2% slope)	0.19
38	State fine sandy loam (0-2% slope)	0.19
8	Catpoint sand (0-4% slope)	0.13
23	Mattan mucky silty clay loam (0-1% slope)	0.11
24	Munden loamy sand (0-2% slope)	0.10
6	Bojac fine sandy loam (0-2% slope)	0.08
29	Osier loamy fine sand (0-2% slope)	0.08
22	Kenansville sand (0-4% slope)	0.07
5	Bojac gravelly loamy sand (0-2% slope)	0.04
28	Nevarc sandy loam (15-50% slope)	0.04
7	Bojac fine sandy loam (2-6% slope)	0.03
16	Kempsville sandy loam (0-2% slope)	0.02
40	Suffolk and Rumford soils (0-2% slope)	0.02
46	Udorthents loamy (0-15% slope)	0.02
25	Myatt loam (0-2% slope)	0.01

Note: 0.37% of the watershed was described to have a soil type of W (Water).

Soil types in the Herring Creek watershed (**Table 1**) were derived using spatial and tabular data available through the Soil Survey Geographic (SSURGO) database for Caroline County and King William County, Virginia. This information is provided by the Natural Resources Conservation Service of the United States Department of Agriculture. The SSURGO database identified forty-six soil types present in the Herring Creek watershed, each of which are summarized below. **Figure 2** shows the location of these soil types in the watershed.

Altavista - Altavista is a nearly level to gently sloping, very deep, moderately well drained soil. Typically the surface layer is fine sandy loam about 14 inches thick. The surface layer has a moderately low content of organic matter. The slowest permeability is moderate. It has a high available water capacity and a low shrink swell potential. This soil is very rarely flooded and is not ponded. The top of the seasonal high water table is at 24 inches. This soil is not hydric.

Bama - Bama is a gently sloping to moderately sloping, very deep, well drained soil. Typically the surface layer is sandy loam about 4 inches thick. The surface layer has a low content of organic matter. The slowest permeability is moderate. It has a moderate available water capacity and a low shrink swell potential. This soil is not flooded and is not ponded. The seasonal high water table is at a depth of more than 6 feet. This soil is not hydric.

Bibb - Bibb is a nearly level to gently sloping, very deep, poorly drained soil. Typically the surface layer is sandy loam about 6 inches thick. The surface layer has a moderate content of organic matter. The slowest permeability is moderate. It has a moderate available water capacity and a low shrink swell potential. This soil is frequently flooded and is not ponded. The top of the seasonal high water table is at 6 inches. This soil is hydric.

Bojac - Bojac is a nearly level to moderately sloping, very deep, well drained soil. Typically the surface layer is sandy loam about 8 inches thick. The surface layer has a moderately low content of organic matter. The slowest permeability is moderately rapid. It has a low available water capacity and a low shrink swell potential. This soil is very rarely flooded and is not ponded. The top of the seasonal high water table is at 60 inches. This soil is not hydric.

Catpoint - Catpoint is a nearly level to moderately sloping, very deep, somewhat excessively drained soil. Typically the surface layer is sand about 5 inches thick. The surface layer has a low content of organic matter. The slowest permeability is rapid. It has a low available water capacity and a low shrink swell potential. This soil is not flooded and is not ponded. This soil is not hydric.

Chastain - Chastain is a nearly level to gently sloping, very deep, poorly drained soil. Typically the surface layer is loam about 5 inches thick. The surface layer has a moderate content of organic matter. The slowest permeability is slow. It has a low available water capacity and a moderate shrink swell potential. This soil is frequently flooded and is not ponded. The top of the seasonal high water table is at 6 inches. This soil is hydric.

Conetoe - Conetoe is a nearly level to moderately sloping, very deep, well drained soil. Typically the surface layer is loamy fine sand about 29 inches thick. The surface layer has a moderately low content of organic matter. The slowest permeability is moderately rapid. It has a low available water capacity and a low shrink swell potential. This soil is not flooded and is not ponded. The seasonal high water table is at a depth of more than 6 feet. This soil is not hydric.

Daleville - Daleville is a nearly level to gently sloping, very deep, poorly drained soil. Typically the surface layer is silt loam about 5 inches thick. The surface layer has a moderately low content of organic matter. The slowest permeability is very slow. It has a high available water capacity and a moderate shrink swell potential. This soil is not flooded and is not ponded. The top of the seasonal high water table is at 6 inches. This soil is hydric.

Emporia - Emporia is a nearly level to very steep, very deep, well drained soil. Typically the surface layer is fine sandy loam about 17 inches thick. The surface layer has a moderately low content of organic matter. The slowest permeability is very slow. It has a moderate available water capacity and a moderate shrink swell potential. This soil is not flooded and is not ponded. The top of the seasonal high water table is at 45 inches. This soil is not hydric.

Eulonia - Eulonia is a gently sloping to moderately sloping, very deep, moderately well drained soil. Typically the surface layer is fine sandy loam about 7 inches thick. The surface layer has a moderately low content of organic matter. The slowest permeability is moderately slow. It has a moderate available water capacity and a low shrink swell potential. This soil is not flooded and is not ponded. The top of the seasonal high water table is at 30 inches. This soil is not hydric.

Eunola - Eunola is a nearly level to moderately sloping, very deep, moderately well drained soil. Typically the surface layer is sandy loam about 10 inches thick. The surface layer has a moderately low content of organic matter. The slowest permeability is moderate. It has a moderate available water capacity and a low shrink swell potential. This soil is not flooded and is not ponded. The top of the seasonal high water table is at 24 inches. This soil is not hydric.

Kempsville - Kempsville is a nearly level to very steep, very deep, well drained soil. Typically the surface layer is sandy loam about 7 inches thick. The surface layer has a moderately low content of organic matter. The slowest permeability is moderate. It has a moderate available water capacity and a low shrink swell potential. This soil is not flooded and is not ponded. The seasonal high water table is at a depth of more than 6 feet. This soil is not hydric.

Kenansville - Kenansville is a nearly level to moderately sloping, very deep, well drained soil. Typically the surface layer is sand about 34 inches thick. The surface layer has a moderately low content of organic matter. The slowest permeability is moderate. It has a low available water capacity and a low shrink swell potential. This soil is not flooded and is not ponded. The seasonal high water table is at a depth of more than 6 feet. This soil is not hydric.

Kinston - Kinston is a nearly level to gently sloping, very deep, poorly drained soil. Typically the surface layer is fine sandy loam about 8 inches thick. The surface layer has a moderate content of organic matter. The slowest permeability is moderate. It has a moderate available water capacity and a low shrink swell potential. This soil is frequently flooded and is not ponded. The top of the seasonal high water table is at 6 inches. This soil is hydric.

Mattan - Mattan is a nearly level, very deep, very poorly drained soil. Typically the surface layer is mucky silty clay loam about 14 inches thick. The surface layer has a very high content of organic matter. The slowest permeability is moderate. It has a high available water capacity and a low shrink swell potential. This soil is frequently flooded and is not ponded. The top of the seasonal high water table is at 0 inches. This soil is hydric.

Munden - Munden is a nearly level to gently sloping, very deep, moderately well drained soil. Typically the surface layer is loamy sand about 13 inches thick. The surface layer has a low content of organic matter. The slowest permeability is moderate. It has a moderate available water capacity and a low shrink swell potential. This soil is not flooded and is not ponded. The top of the seasonal high water table is at 24 inches. This soil is not hydric.

Myatt - Myatt is a nearly level to gently sloping, very deep, poorly drained soil. Typically the surface layer is loam about 9 inches thick. The surface layer has a moderate content of organic matter. The slowest permeability is moderately slow. It has a high available water capacity and a low shrink swell potential. This soil is rarely flooded and is not ponded. The top of the seasonal high water table is at 6 inches. This soil is hydric.

Nansemond - Nansemond is a nearly level to gently sloping, very deep, moderately well drained soil. Typically the surface layer is loamy fine sand about 16 inches thick. The surface layer has a low content of organic matter. The slowest permeability is moderately rapid. It has a low available water capacity and a low shrink swell potential. This soil is not flooded and is not ponded. The top of the seasonal high water table is at 24 inches. This soil is not hydric.

Nevarc - Nevarc is a moderately sloping to very steep, very deep, moderately well drained soil. Typically the surface layer is sandy loam about 9 inches thick. The surface layer has a moderately low content of organic matter. The slowest permeability is very slow. It has a moderate available water capacity and a moderate shrink swell potential. This soil is not flooded and is not ponded. The top of the seasonal high water table is at 27 inches. This soil is not hydric.

Osier - Osier is a nearly level to gently sloping, very deep, poorly drained soil. Typically the surface layer is loamy fine sand about 7 inches thick. The surface layer has a moderate content of organic matter. The slowest permeability is rapid. It has a low available water capacity and a low shrink swell potential. This soil is rarely flooded and is not ponded. The top of the seasonal high water table is at 3 inches. This soil is hydric.

Pactolus - Pactolus is a nearly level to gently sloping, very deep, moderately well drained soil. Typically the surface layer is loamy sand about 33 inches thick. The surface layer has a moderately low content of organic matter. The slowest permeability is rapid. It has a low available water capacity and a low shrink swell potential. This soil is not flooded and is not ponded. The top of the seasonal high water table is at 27 inches. This soil is not hydric.

Remlik - Remlik is a moderately sloping to very steep, very deep, well drained soil. Typically the surface layer is loamy sand about 6 inches thick. The surface layer has a moderately low content of organic matter. The slowest permeability is moderate. It has a moderate available water capacity and a low shrink swell potential. This soil is not flooded and is not ponded. The top of the seasonal high water table is at 60 inches. This soil is not hydric.

Roanoke - Roanoke is a nearly level to gently sloping, very deep, poorly drained soil. Typically the surface layer is loam about 12 inches thick. The surface layer has a moderately low content of organic matter. The slowest permeability is very slow. It has a moderate available water capacity and a moderate shrink swell potential. This soil is rarely flooded and is not ponded. The top of the seasonal high water table is at 6 inches. This soil is hydric.

Rumford - Rumford is a nearly level to moderately sloping, very deep, well drained soil. Typically the surface layer is loamy sand about 11 inches thick. The surface layer has a low content of organic matter. The slowest permeability is moderately rapid. It has a moderate available water capacity and a low shrink swell potential. This soil is not flooded and is not ponded. The seasonal high water table is at a depth of more than 6 feet. This soil is not hydric.

Seabrook - Seabrook is a nearly level to gently sloping, very deep, moderately well drained soil. Typically the surface layer is loamy fine sand about 4 inches thick. The surface layer has a moderately low content of organic matter. The slowest permeability is rapid. It has a low available water capacity and a low shrink swell potential. This soil is not flooded and is not ponded. The top of the seasonal high water table is at 36 inches. This soil is not hydric.

<u>Slagle</u> - Slagle is a nearly level to moderately steep, very deep, moderately well drained soil. Typically the surface layer is fine sandy loam about 12 inches thick. The surface layer has a moderately low content of organic matter. The slowest permeability is very slow. It has a moderate available water capacity and a moderate shrink swell potential. This soil is not flooded and is not ponded. The top of the seasonal high water table is at 60 inches. This soil is not hydric.

<u>State</u> - State is a nearly level to moderately sloping, very deep, well drained soil. Typically the surface layer is fine sandy loam about 17 inches thick. The surface layer has a moderately low content of organic matter. The slowest permeability is moderate. It has a moderate available water capacity and a low shrink swell potential. This soil is very rarely flooded and is not ponded. The top of the seasonal high water table is at 60 inches. This soil is not hydric.

<u>Suffolk</u> - Suffolk is a nearly level to moderately sloping, very deep, well drained soil. Typically the surface layer is fine sandy loam about 20 inches thick. The surface layer has a moderately low content of organic matter. The slowest permeability is moderate. It has a moderate available water capacity and a low shrink swell potential. This soil is not flooded and is not ponded. The seasonal high water table is at a depth of more than 6 feet. This soil is not hydric.

<u>Tarboro</u> - Tarboro is a nearly level to very steep, very deep, somewhat excessively drained soil. Typically the surface layer is loamy sand about 9 inches thick. The surface layer has a low content of organic matter. The slowest permeability is rapid. It has a very low available water capacity and a low shrink swell potential. This soil is very rarely flooded and is not ponded. The seasonal high water table is at a depth of more than 6 feet. This soil is not hydric.

<u>Tomotley</u> - Tomotley is a nearly level to gently sloping, very deep, poorly drained soil. Typically the surface layer is sandy loam about 10 inches thick. The surface layer has a moderate content of organic matter. The slowest permeability is moderately slow. It has a moderate available water capacity and a low shrink swell potential. This soil is rarely flooded and is not ponded. The top of the seasonal high water table is at 6 inches. This soil is hydric.

<u>Udorthents</u> - Udorthents are nearly level to gently sloping soils in areas where gravel, marl, road base, and other foundation material has been mined. Other uses include dumps, landfills, and borrow pits.

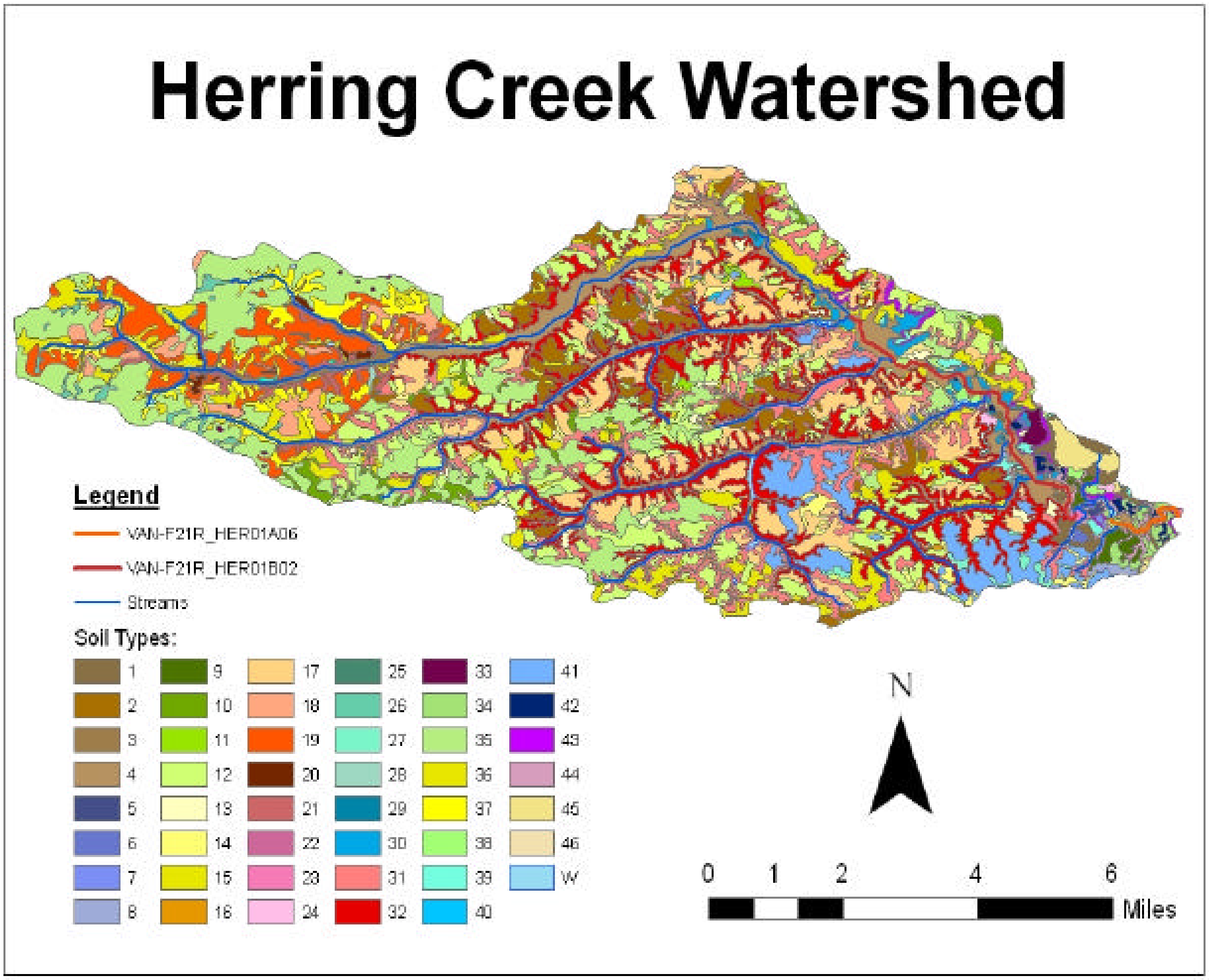


Figure 2. Soil Types in the Herring Creek Watershed.

Land Use

The Herring Creek watershed is approximately 30,210 acres in size and is predominately forested, with nearly eighty percent (76.93%) of the land use attributed to deciduous, evergreen, and mixed forests. The production of crops and pasture/hay account for 15.86%, while wetlands account for 3.34% of the total land use of the watershed. The remaining 3.87% of the Herring Creek watershed area is shared by a variety of land use alternatives, which are displayed in **Figure 3**. Land use coverage information was obtained from a 2000 land cover layer provided by the Regional Earth Science Applications Center (RESAC) at the University of Maryland, College Park.

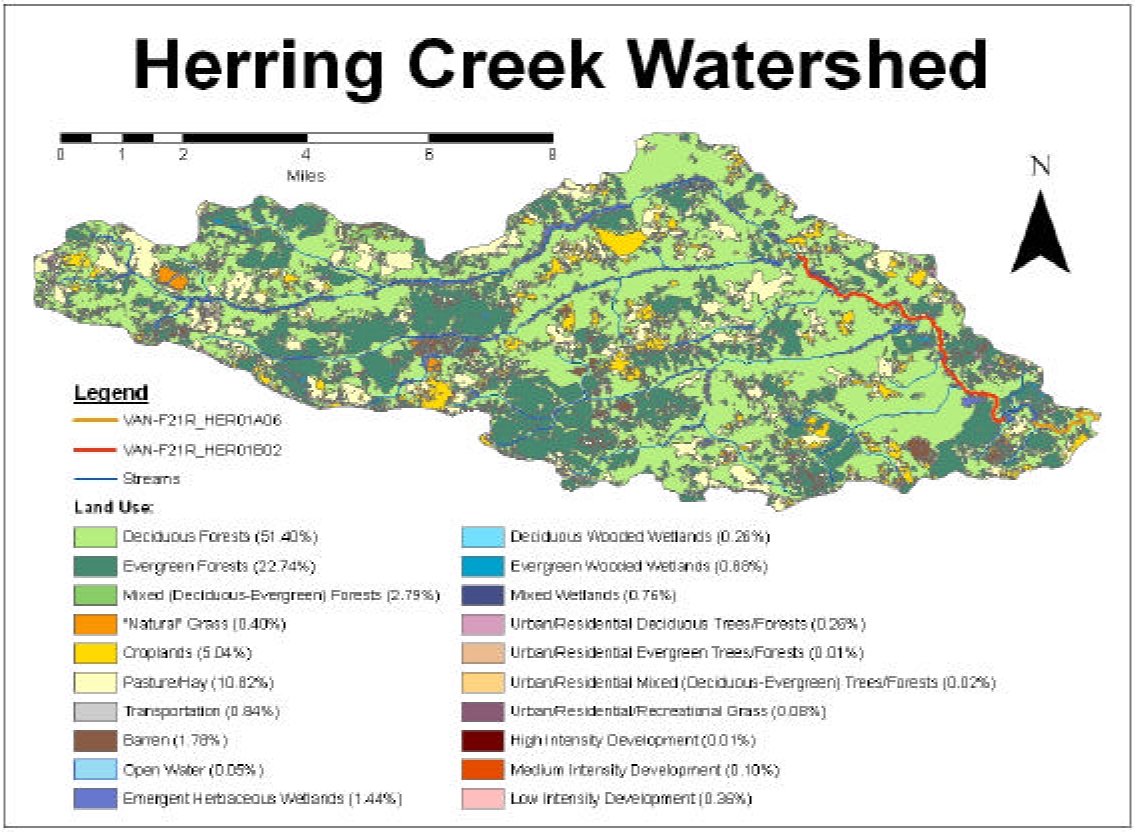


Figure 3. Land Use in the Herring Creek Watershed.

Climate

The climate summary for Herring Creek comes from a weather station located in Walkerton, VA, with a period of record from 7/ 1/1932 to 9/30/2005*.* The Walkerton weather station is approximately 9 miles southeast of Herring Creek*.* The average annual maximum temperature at the weather station is 69.4°F and the average minimum temperature is 45.9°F. The average annual rainfall for the Walkerton Station is 43.83 inches (**Table 2**).

Table 2. Climate Summary for Walkerton, Virginia (448829).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	48.2	51.3	59.9	70.6	78.3	85.4	88.4	86.8	81.3	71.2	61.2	50.4	69.4
Average Min. Temperature (F)	26.4	27.7	34.7	43.8	53.7	62.4	66.8	65.4	58.3	45.9	36.6	28.5	45.9
Average Total Precipitation (in.)	3.47	3.05	3.85	3.05	3.93	3.71	4.95	4.49	3.73	3.09	3.24	3.27	43.83

3. Description of Water Quality Problem/Impairment

A portion of Herring Creek was first recognized as impaired for the aquatic life use, based on the pH parameter, in 2002. Segment VAN-F21R_HER01B02 was listed in Attachment B (Plaintiff's list of waters) of the 1999 Consent Decree, as identified in the <u>American Canoe Association and the American Littoral Society vs. the United States Environmental Protection Agency</u> decision. Additional monitoring demonstrated that there was enough evidence to support listing of this segment, facilitating the inclusion of the segment in Attachment C (Plaintiff's list of waters that were added to the 303(d) list in 2002) for pH. Because of the segment's inclusion on the Impaired Waters list, a TMDL study, initiated to identify and addressing the source(s) of the pH impairment, is required.

Sampling data from the 2002 Assessment showed that 19 of 26 samples (73.1%) were below the lower range (6.0 SU) of the pH water quality criteria for Class III waters as established in 9 VAC 25-260-50 of the Virginia Water Quality Standards (**Figure 4**). During the 2004 and 2006 assessment periods, sufficient excursions of the pH standard at station 8-HER005.12 have demonstrated that the segment is not supporting the aquatic life use. Between 1998 and 2002, sampling events showed that 15 of 19 samples (78.9%) were below the lower range (6.0 SU) of the pH water quality criteria for Class III waters as established in 9 VAC 25-260-50 of the Virginia Water Quality Standards (**Figure 5**). The data for the 2006 assessment window show that 10 of 14 samples (71.4%) were below the lower range of the pH water quality criteria (**Figure 6**). The horizontal line at the 6.0 SU mark represents the minimum water quality criterion. The data points below the 6.0 SU line illustrate excursions from the water quality standard.

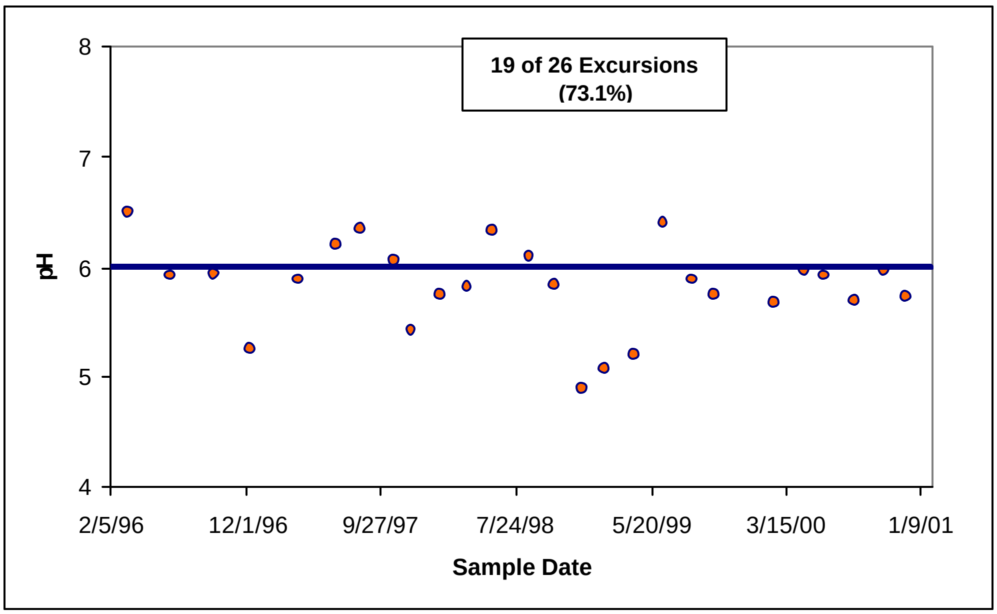


Figure 4: pH Values for Herring Creek at Route 609 (8-HER005.12) during the 2002 Assessment Window.

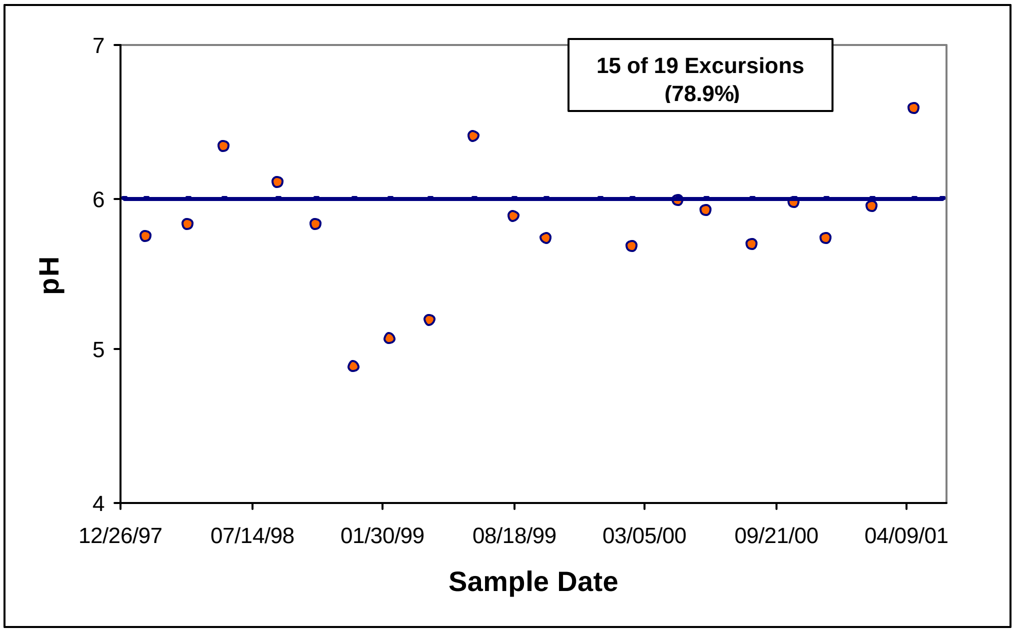


Figure 5. pH Values for Herring Creek at Route 609 (8-HER005.12) during the 2004 Assessment Window.

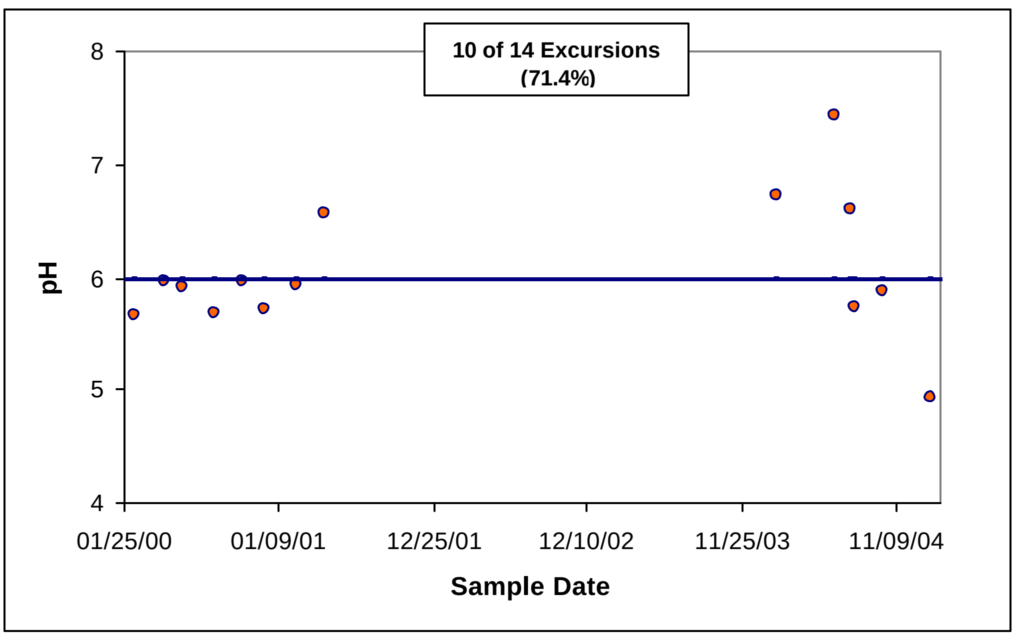


Figure 6. pH Values for Herring Creek at Route 609 (8-HER005.12) during the 2006 Assessment Window.

Out of 41 pH values collected between June 1995 and June 2005 at station 8-HER005.12, 25 (60.9%) were below the lower water quality standard for pH of 6.0 SU. A time series graph of the data collected at station 8-HER005.12 show the pH values, ranging from 4.89 to 7.44 SU (**Figure 7**).

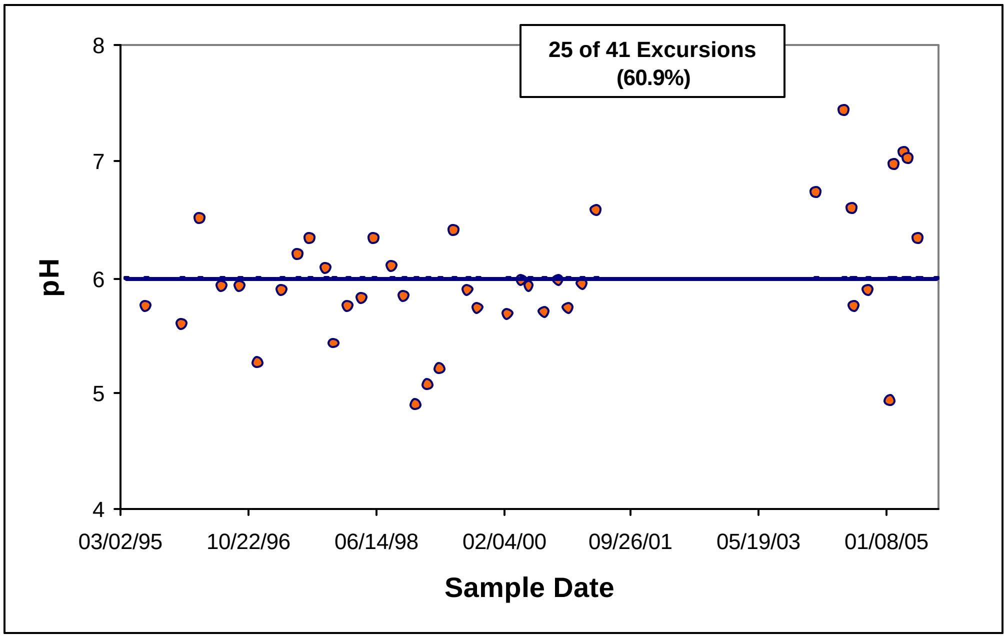


Figure 7. All pH Values for Herring Creek at Route 609 (8-HER005.12) from 1995 to 2005.

In addition to the monitoring performed at the Herring Creek listing station (8-HER005.12), monitoring was also conducted at 8-HER000.33, at the Route 600 bridge crossing. Eleven samples were collected at this station, from February 2004 to June 2005. **Figure 8** shows that three of 11 samples (27.3%) were below the lower water quality standard for pH of 6.0 SU.

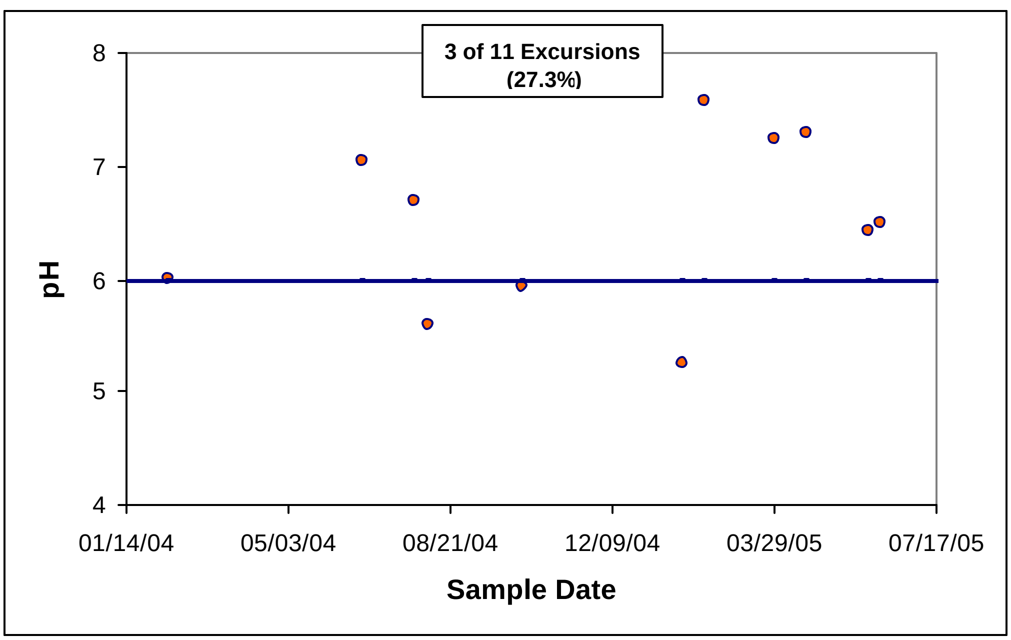


Figure 8. All pH Values for Herring Creek at Route 600 (8-HER000.33) for 2004 and 2005.

4. Water Quality Standard

According to Virginia Water Quality Standards (9 VAC 25-260-5), the term *"water quality standards means provisions of state or federal law which consist of a designated use or uses for the waters of the Commonwealth and water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law (§62.1-44.2 et seq. of the Code of Virginia) and the federal Clean Water Act (33 USC §1251 et seq.)."*

As stated above, Virginia water quality standards consist of a designated use or uses and a water quality criteria. These two parts of the applicable water quality standard are presented in the sections that follow.

4.1. Designated Uses

According to Virginia Water Quality Standards (9 VAC 25-260-10A), *"All state waters are designated for the following uses: recreational uses (e.g., swimming and boating); the propagation and growth of a balanced indigenous population of aquatic life, including game fish, which might be reasonably expected to inhabit them; wildlife; and the production of edible and marketable natural resources (e.g., fish and shellfish)."*

As stated above, Herring Creek must support all designated uses by meeting all applicable criteria. Herring Creek has been assessed as not supporting the aquatic life use due to excursions of the pH criteria that is designed to protect aquatic life in Class III waters.

4.2. Applicable Water Quality Criteria

The Class III water quality criteria for pH in the Herring Creek watershed are a minimum pH 6.0 SU and a maximum pH 9.0 SU (**Table 3**).

Table 3. Applicable Water Quality Standards.

Parameter	Minimum pH (SU)	Maximum pH (SU)
pH	6.0	9.0

If the waterbody exceeds the criterion listed above in more than 10.5 percent of samples, the waterbody is classified as impaired and a TMDL must be developed and implemented to bring the waterbody into compliance with the water quality criterion. However, in the case of Herring Creek there is reason to believe that the waterbody has been mis-classified and that the apparent impairment is due to the swampy nature of the stream. In this document, VADEQ applies a proposed methodology for determining if pH impairments in free-flowing streams are due to natural conditions, thus allowing Herring Creek to be reclassified as Class VII (Swamp Waters). This methodology is based on the VADEQ's Procedure for Natural Condition Assessment of Low pH and Low DO in Virginia Streams, prepared in October 2004 and submitted to the EPA on November 30, 2004.

5. Methodology for Natural Conditions Assessment

The level of acidity as registered by pH in a water body is determined by a balance between organic acids produced by decay of vegetative material, and buffering capacity. Conditions in a stream that would typically be associated with naturally low pH include slow-moving, ripple-less waters or wetlands where the decay of organic matter produces organic acids. These situations can be compounded by anthropogenic activities that contribute excessive nutrients or readily available organic matter to these systems. The general approach to determine if DO and pH impairments in streams are due to natural conditions is to assess a series of water quality and hydrologic criteria to determine the likelihood of an anthropogenic source. A logical 4-step process for identifying natural conditions that result in low DO and/or pH levels and for determining the likelihood of anthropogenic impacts that will exacerbate the natural condition is described below.

Step 1. Determine slope and appearance.

Step 2. Determine nutrient levels.

Step 3. Determine degree of seasonal fluctuation (for DO only).

Step 4. Determine anthropogenic impacts.

The results from this methodology will be used to determine if the stream should be re-classified as Class VII Swamp Waters. The methodology is listed in Appendix A of this report.

6. Natural Conditions Assessment for Herring Creek

6.1 7Q10 Low Flow Screening

The 7Q10 flow of a stream is the lowest streamflow for seven consecutive days that occurs on average once every ten years. The first step for low flow 7Q10 screening is to determine the most accurate 7Q10 available. There are no flow gaging stations on Herring Creek; however there is one on the Mattaponi River near Beulahville, VA (Station 01674500) with a drainage area of 601 mi^2. The Beulahville gage is co-located with the VADEQ and USGS station 8-MPN054.17. The 7Q10 flow for the Beulahville gage is 8.1 cfs.

The pH Instantaneous Water Quality Standard applies **AT** 7Q10 flow, but **NOT** below 7Q10 flow (9 VAC 25-260-50). Therefore in streams where the 7Q10 > 0 cfs, pH less than 6.0 taken at flows below 7Q10 are not water quality standard excursions. However, in streams where the 7Q10 = 0 cfs, **ALL** pH data < pH 6.0 SU are standard violations, even if the flow = 0 cfs when the pH was taken.

No exceedances of pH occurred on Herring Creek below 7Q10 flow at station 8-MPN054.17. Therefore, all pH values are considered in this assessment.

6.2 Slope and Appearance

The slope of Herring Creek was determined using DeLorme's <u>3-D TopoQuads</u> software. The hydrologic slope from the headwaters of Herring Creek to the confluence with the Mattaponi River is estimated at 0.17%, which is considered low slope. As the land elevation is 213.08 feet at the headwaters and 63.20 feet at the confluence with the Mattaponi River, and the segment is 17.2 miles in length, with 5280 feet in a mile, the slope value was derived using the following calculation:

$$[(213.08 \text{ ft} - 63.20 \text{ ft}) / (17.2 \text{ miles} \times 5280 \text{ ft})] \times 100 = \mathbf{0.17\%}$$

Visual inspections from bridges over Route 604, Route 601, Route 677, and Route 693 revealed large swampy areas and frequent side channels connected to the mainstem of Herring Creek. There are large inputs of decaying vegetation into Herring Creek from the adjacent swampy areas, oxbows, and other areas of forested land with heavy tree canopy throughout the watershed. This decaying vegetation produces acids which in turn can lead to lower pH values. **Figures 9, 10, and 11** illustrate the swamp-like conditions found along Herring Creek.

In addition, during the physical investigation of the impaired segments of Herring Creek, it was discovered that Herring Creek Millpond has been drained (**Figure 12**). Currently, Herring Creek extends from the confluence with Dorrell Creek until the confluence with the Mattaponi River solely as a river.

Figure 9. Swampy Area of Herring Creek at Route 677.

Figure 10. Herring Creek at Route 693.

Figure 11. Herring Creek at Route 601.

Figure 12. Former Site of the Herring Millpond.

6.3 Instream Nutrients

The VADEQ has collected nutrient data at station 8-HER005.12 and, for the purpose of this report, reviewed the results of samples taken from June 1995 to June 2005. The average nutrient concentrations in Herring Creek are below the national background nutrient concentrations for streams in undeveloped areas, as described by the USGS in 1999. The national background levels are: nitrate < 0.6 mg/L; TN (TKN + NO_3 + NO_2) < 1.0 mg/L; and TP < 0.1 mg/L. These low nutrient levels are not indicative of human impact (**Table 4**).

Table 4. Nutrient Data for Station 8-HER005.12 (1995-2005).

Parameter	Average Concentration	Number of Samples
Total Phosphorus	0.055 mg / L	44
Nitrate	0.077 mg / L	42
Total Nitrogen (TKN + NO_3 + NO_2)	0.736 mg / L	44

Note: The nitrate, nitrite, and total phosphorus concentrations sometimes were below the detection limit. In these instances, the detection limit value was used as the concentration for that parameter.

6.4 Impact from Point Source Dischargers and Land Use

There is one individually permitted facility in the Herring Creek Watershed, as shown in **Table 5.**

Table 5. Permitted Point Source Facilities in the Herring Creek Watershed.

Stream Name	Facility Name	VPDES Permit Number	Discharge Type[1]	Design Flow (MGD)	Permitted *pH* Limit
Unnamed Tributary to Herring Creek	Department of Corrections – Caroline County Correctional Unit 2	VA0023329	Municipal Minor	0.037	6.0 SU – 9.0 SU

The Virginia Department of Corrections holds an individual VPDES Permit for the Caroline County Correctional Unit 2 Sewage Treatment Plant. This facility discharges into an unnamed tributary to Herring Creek, which then feeds into the mainstem of Herring Creek just downstream of the Route 677 bridge crossing. This unnamed tributary joins Herring Creek upstream of the DEQ monitoring station 8-HER005.12. Discharges from the facility have a permitted pH limit of 6.0 SU - 9.0 SU. This point source most likely has no effect on the low pH in Herring Creek.

6.5 Human Impact from Acid Deposition

Acid deposition is expected to occur in the Herring Creek watershed, however rainfall pH data are difficult to collect and do not exist near Herring Creek. The closest available rainfall pH data come from the National Atmospheric Deposition Program / NTN station in Charlottesville, VA. Acid deposition occurred in the Charlottesville dataset, with weekly rainfall pH during the period from 1990 to 2003 averaging 4.35 SU (SD = 0.277, n = 428), with a minimum of 3.43 SU and maximum of 5.29 SU. According to the EPA, the natural pH of rain is about 5.5.

One method to assess whether acid deposition adversely impacts low pH in a waterbody is to compare daily precipitation data from the Virginia State Climatology Office to DEQ ambient water quality monitoring field pH data. During the last DEQ water quality standards triennial review in 2003, DEQ filtered daily rainfall data for 1996 - 2003 according to water sample collection dates at DEQ ambient water quality monitoring stations that were within an approximate 15-mile radius of precipitation monitoring stations.

Precipitation amounts and field pH values were graphed together and correlation factors calculated. The only discernable pattern was a general negative correlation of precipitation to pH and the majority of r-values were well below 0.5, which does not indicate a close correlation between the variables. This comparison is described in correspondence to USEPA Region III dated October 14, 2003 in Appendix C.
However the extent to which stream pH is decreased by acid deposition in Virginia cannot be decisively established. Significant human impact from acid deposition is inconclusive.

6.6 Associated Mainstem and Tributary Site pH

The majority of water quality monitoring along Herring Creek has occurred at stations 8-HER000.33 and 8-HER005.12. Values for the pH parameter have been recorded at six other stations along Herring Creek, as noted in **Table 6**, but each of these stations has only one sampling event. The closest downstream DEQ monitoring station is located downstream from the confluence of Herring Creek with the Mattaponi River. Station 8-MPN039.10 is included in the Natural Streams Assessment for the Mattaponi River report, completed by the Piedmont Regional Office of Virginia DEQ in November 2005. The listed segment in that publication began at rivermile 57.37, where the Mattaponi River confluences with Maracossic Creek.

Table 6. Other pH Monitoring along Herring Creek.

Station	Location	Date	pH Value
8-HER007.12	Route 628	06/30/95	5.62
8-HER008.85	Route 608	06/30/95	5.60
8-HER012.42	Route 604	06/30/95	5.72
8-HER012.99	Downstream of Route 601	05/21/02	6.20
8-HER013.23	Route 601	07/21/83	6.10
8-HER014.85	Route 677	07/21/83	5.80

As none of the tributaries to Herring Creek have adequate chemical monitoring data to determine if these streams are naturally occurring swamp waters, the tributaries appearing in the 1:100,000-scale NHD layer were assessed for low slope conditions, defined through this process as less than 0.50%. Dorrell Creek, Fork Bridge Creek, and Millpond Creek were the only tributaries to demonstrate sufficiently low slopes, when evaluated using DeLorme's 3-D TopoQuads software. The slope values were derived using the following calculation:

Dorrell Creek *[(223.27 ft – 77.83 ft) / (8.03 miles x 5280 ft)] x 100 =* ***0.34%***

Fork Bridge Creek *[(213.23 ft – 47.37 ft) / (7.04 miles x 5280 ft)] x 100 =* ***0.45%***

Millpond Creek *[(213.95 ft – 185.76 ft) / (2.53 miles x 5280 ft)] x 100 =* ***0.21%***

Based on this information, field observations were taken at points where a bridge crosses the tributary stream. **Figure 13**, below, illustrates six such crossings; three along Dorrell Creek, two along Fork Bridge Creek, and one along Millpond Creek. All six sites revealed stagnant to relatively slow moving water, which varied in color from light brown to nearly black. The streams are located in highly forested areas and often contained aquatic vegetation, such as marshy grasses. **Figures 14, 15, 16, 17 and 18** illustrate the swamp-like conditions found along these tributaries. Although a chemical analysis of the nutrient levels in these tributaries is not possible, due to lack of monitoring events along these streams, the low slopes and physical properties of Dorrell Creek, Fork Bridge Creek, and Millpond Creek suggest that these named tributaries to Herring Creek should be reclassified as swamp waters, along with the mainstem Herring Creek.

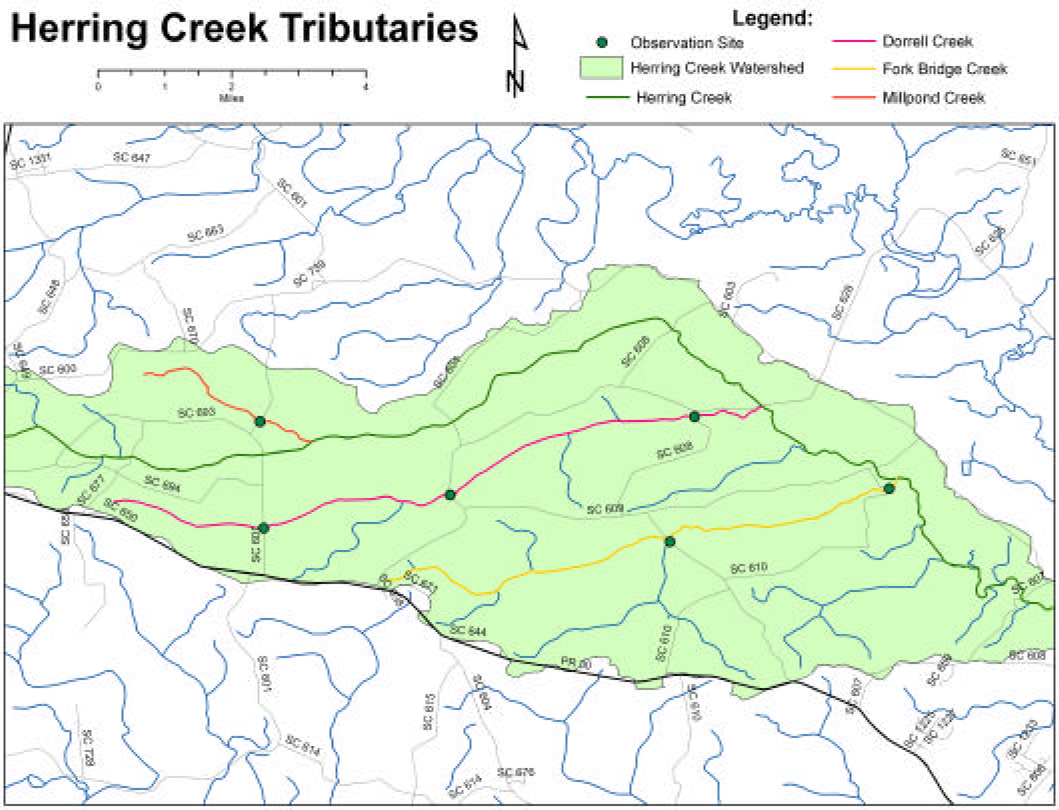


Figure 13. Herring Creek Tributaries and Observation Sites.

Figure 14. Dorrell Creek at Route 601.

Figure 15. Dorrell Creek at Route 604.

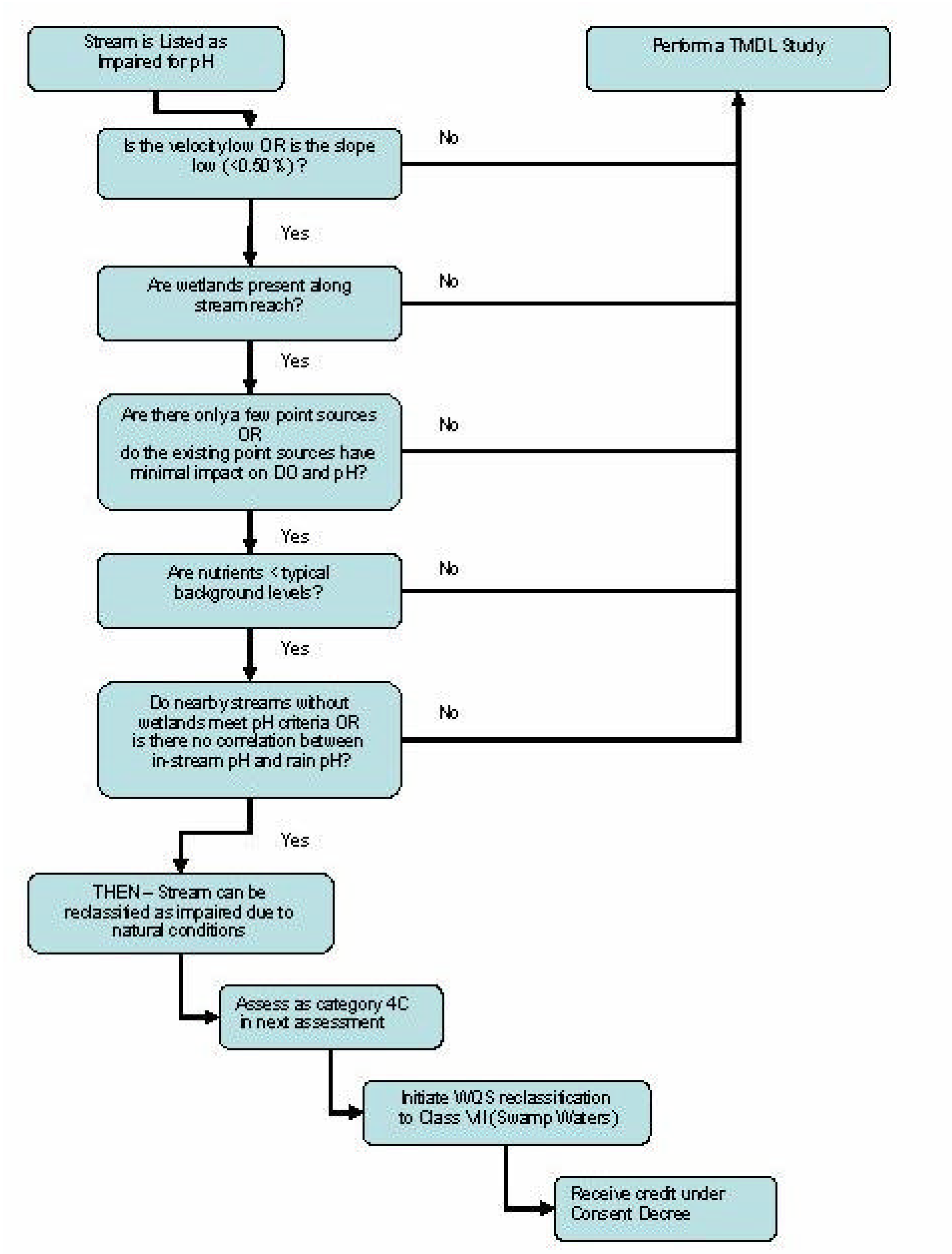
Figure 16. Dorrell Creek at Route 608.

Figure 17. Fork Bridge Creek at Route 608.

Figure 18. Millpond Creek at Route 601.

7.0 Conclusion

The following decision process is proposed for determining whether low pH values are due to natural conditions:



The slope of Herring Creek from its headwaters to the confluence with the Mattaponi River is 0.17%, which is considered a low slope. There are large inputs of decaying vegetation into Herring Creek from the adjacent swampy areas, oxbows, and other areas of forested land with heavy tree canopy throughout the watershed. This decaying vegetation produces acids which in turn can lead to lower pH values. Herring Creek also exhibits low nutrient concentrations below national background levels in streams from undeveloped areas. These levels of nutrients are not indicative of human impact.

There is one individual VPDES permit (VA0023329) in the Herring Creek watershed which is held by the Virginia Department of Corrections for the Caroline County Correctional Unit 2 Sewage Treatment Plant. This facility discharges into an unnamed tributary to Herring Creek, which then feeds into the mainstem of Herring Creek just downstream of the Route 677 bridge crossing. This unnamed tributary joins Herring Creek upstream of the DEQ monitoring station 8-HER005.12. Discharges from the facility have a permitted pH limit of 6.0 - 9.0 SU. This point source most likely has no effect on the low pH in Herring Creek. The Residential / Commercial land use (approximately .5% of the watershed) most likely has no pH effect on streams in the watershed. The watershed is predominately forested (approximately 77%).

There is not a close correlation between precipitation amounts and field pH at DEQ ambient water quality monitoring stations. The only discernable pattern has been a general negative correlation of precipitation to pH and the majority of r-values were well below 0.5, which does not indicate a close correlation between the variables. However, the extent to which stream pH is decreased by acid deposition cannot be conclusively determined.

Based on the above information, a change in the water quality standards classification to Class VII Swampwater due to natural conditions, rather than a TMDL, is indicated for Herring Creek, from its headwaters to its confluence with the Mattaponi River, and including its named tributaries Dorrell Creek, Fork Bridge Creek, and Millpond Creek.

8.0. Public Participation

DEQ performed the assessment of Herring Creek low pH natural condition in lieu of a TMDL. Therefore neither a TMDL Technical Advisory Committee (TAC) meeting nor a public meeting was involved. Public participation will occur during the next water quality standards triennial review process.

9.0 References

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Appendix A

PROCEDURE FOR NATURAL CONDITION ASSESSMENT OF LOW PH AND LOW DO IN VIRGINIA STREAMS

Procedure for Natural Condition Assessment of low pH and low DO in Virginia Streams

Prepared by Virginia Department of Environmental Quality October 2004

I. INTRODUCTION

Virginia's list of impaired waters currently shows many waters as not supporting the aquatic life use due to exceedances of pH and/or DO criteria that are designed to protect aquatic life in Class III waters. However, there is reason to believe that most of these streams or stream segments have been mis-classified and should more appropriately be classified as Class VII, Swamp Waters. This document presents a procedure for assessing if natural conditions are the cause of the low pH and/or low DO levels in a given stream or stream segment.

The level of dissolved oxygen (DO) in a water body is determined by a balance between oxygen-depleting processes (*e.g.*, decomposition and respiration) and oxygen-restoring processes (*e.g.*, aeration and photosynthesis). Certain natural conditions promote a situation where oxygen-restoring processes are not sufficient to overcome the oxygen- depleting processes. The level of acidity as registered by pH in a water body is determined by a balance between organic acids produced by decay of vegetative material, and buffering capacity.

Conditions in a stream that would typically be associated with naturally low DO and/or naturally low pH include slow-moving, ripple-less waters. In such waters, the decay of organic matter depletes DO at a faster rate than it can be replenished and produces organic acids (tannins, humic and fulvic substances). These situations can be compounded by anthropogenic activities that contribute excessive nutrients or readily available organic matter to these systems.

The general approach to determine if DO and pH impairments in streams are due to natural conditions is to assess a series of water quality and hydrologic criteria to determine the likelihood of an anthropogenic source. A logical 4-step process for identifying natural conditions that result in low DO and/or pH levels and for determining the likelihood of anthropogenic impacts that will exacerbate the natural condition is described below. DEQ staff is proposing to use this approach to implement State Water Control Law 9 VAC 25-260-55, Implementation Procedure for Dissolved Oxygen Criteria in Waters Naturally Low in Dissolved Oxygen.

Waters that are shown to have naturally low DO and pH levels will be re-classified as Class VII, Swamp Waters, with the associated pH criterion of 4.3 to 9.0 SU. An associated DO criterion is currently being developed from swamp water data. A TMDL is not needed for these waters. An assessment category of 4C will be assigned until the waterbody has been re-classified.

II. NATURAL CONDITION ASSESSMENT

Following a description of the watershed (including geology, soils, climate, and land use), a description of the DO and/or pH water quality problem (including a data summary, time series and monthly data distributions), and a description of the water quality criteria that were the basis for the impairment determination, the available information should be evaluated in four steps.

<u>Step 1. Determine appearance and flow/slope.</u>

Streams or stream segments that have naturally low DO (< 4 mg/L) and low pH (< 6 SU) are characterized by very low slopes and low velocity flows (flat water with low reaeration rates). Decaying vegetation in such swampy waters provides large inputs of plant material that consumes oxygen as it decays. The decaying vegetation in a swamp water also produces acids and decreases pH. Plant materials contain polyphenols such as tannin and lignin. Polyphenols and partially degraded polyphenols build up in the form of tannic acids, humic acids, and fulvic acids that are highly colored. The trees of swamps have higher polyphenolic content than the soft-stemmed vegetation of marshes. Swamp streams (blackwater) are therefore more highly colored and more acidic than marsh streams.

Appearance and flow velocity (or slope if flow velocity is not available) must be identified for each stream or stream segment to be assessed for natural conditions and potential re-classification as a Class VII swamp water. This can be done through maps, photos, field measurements or other appropriate means.

Step 2. Determine nutrient levels.

Excessive nutrients can cause a decrease in DO in relatively slow moving systems, where aeration is low. High nutrient levels are an indication of anthropogenic inputs of nitrogen, phosphorus, and possibly organic matter. Nutrient input can stimulate plant growth, and the resulting die-off and decay of excessive plankton or macrophytes can decrease DO levels.

USGS (1999) estimated national background nutrient concentrations in streams and groundwater from undeveloped areas. Average nitrate background concentrations are less than 0.6 mg/L for streams, average total nitrogen (TN) background concentrations are less than 1.0 mg/L, and average background concentrations of total phosphorus (TP) are less than 0.1 mg/L.

Nutrient levels must be documented for each stream or stream segment to be assessed for natural conditions and potential re-classification as a Class VII swamp water. Streams with average concentrations of nutrients greater than the national background concentrations should be further evaluated for potential impacts from anthropogenic sources.

Step 3. Determine degree of seasonal fluctuation (for DO only).

Anthropogenic impacts on DO will likely disrupt the typical seasonal fluctuation seen in the DO concentrations of wetland streams. Seasonal analyses should be conducted for each potential Class VII stream or stream segment to verify that DO is depressed in the summer months and recovers during the winter, as would be expected in natural systems. A weak seasonal pattern could indicate that human inputs from point or nonpoint sources are impacting the seasonal cycle.

Step 4. Determine anthropogenic impacts.

Every effort should be made to identify human impacts that could exacerbate the naturally low DO and/or pH. For example, point sources should be identified and DMR data analyzed to determine if there is any impact on the stream DO or pH concentrations. Land use analysis can also be a valuable tool for identifying potential human impacts.

Lastly, a discussion of acid rain impacts should be included for low pH waters. The format of this discussion can be based either on the process used for the recent Class VII classification of several streams in the Blackwater watershed of the Chowan Basin (letter from DEQ to EPA, 14 October 2003). An alternative is a prototype regional stream comparison developed for Fourmile Creek, White Oak Swamp, Matadequin Creek and Mechumps Creek (all east of the fall line). The example analysis under IV in this document, or the example report prepared for Fourmile Creek, illustrate this approach. For streams west of the fall line, a regional stream comparison for 2004 analyses encompasses Occupacia, Winticomack, and Skinquarter Creeks.

7Q10 Data Screen

If the data warrant it, a data screen should be performed to ensure that the impairment was identified based on valid data. All DO or pH data that violate water quality standards should be screened for flows less than the 7Q10. Data collected on days when flow was < 7Q10 should be eliminated from the data set and the violation rate recalculated accordingly. Only those waters with violation rates determined days with flows > or = 7Q10 flows should be classified as impaired.

In some cases, data were collected when flow was 0 cfs. If the 7Q10 is identified as 0 cfs as well, all data collected under 0 cfs flow would need to be considered in the water quality assessment. In those cases, the impairment should be classified as 4C, Impaired due to natural conditions, no TMDL needed. However, a reclassification to Class VII may not always be appropriate.

III. NATURAL CONDITION CONCLUSION MATRIX

The following decision process should be applied for determining whether low pH and/or low DO values are due to natural conditions and justify a reclassification of a stream or stream segment as Class VII, Swamp Water.

If velocity is low or if slope is low (<0.50%) AND
If wetlands are present along stream reach AND
If no point sources or only point sources with minimal impact on DO and pH AND
If nutrients are < typical background

- average (= assessment period mean) nitrate less than 0.6 mg/L
- average total nitrogen (TN) less than 1.0 mg/L, and
- average total phosphorus (TP) are less than 0.1 mg/L AND

For DO: If seasonal fluctuation is normal AND
For pH: If nearby streams without wetlands meet pH criteria OR if no correlation between in-stream pH and rain pH,

THEN determine as impaired due to natural condition
→ assess as category 4C in next assessment
→ initiate WQS reclassification to Class VII Swamp Water
→ get credit under consent decree

The analysis must state the extent of the natural condition based on the criteria outlined above. A map showing land use, point sources, water quality stations and, if necessary, the delineated segment to be classified as swamp water should be included.

In cases where not all of these criteria apply, a case by case argument must be made based on the specific conditions in the watershed.

Appendix B

GLOSSARY

303(d). A section of the Clean Water Act of 1972 requiring states to identify and list water bodies that do not meet the states' water quality standards.

Ambient water quality. Natural concentration of water quality constituents prior to mixing of either point or nonpoint source load of contaminants. Reference ambient concentration is used to indicate the concentration of a chemical that will not cause adverse impact on human health.

Anthropogenic. Pertains to the [environmental] influence of human activities.

Background levels. Levels representing the chemical, physical, and Bacterial conditions that would result from natural geomorphological processes such as weathering or dissolution.

Best management practices (BMPs). Methods, measures, or practices determined to be reasonable and cost-effective means for a landowner to meet certain, generally non-point source, pollution control needs. BMPs include structural and nonstructural controls and operation and maintenance procedures.

Clean Water Act (CWA). The Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972), Public Law 92-500, as amended by Public Law 96-483 and Public Law 97-117, 33 U.S.C. 1251 et seq. The Clean Water Act (CWA) contains a number of provisions to restore and maintain the quality of the nation's water resources. One of these provisions is section 303(d), which establishes the TMDL program.

Concentration. Amount of a substance or material in a given unit volume of solution; usually measured in milligrams per liter (mg/L) or parts per million (ppm).

Confluence. The point at which a river and its tributary flow together.

Contamination. The act of polluting or making impure; any indication of chemical, sediment, or Bacterial impurities.

Designated uses. Those uses specified in water quality standards for each waterbody or segment whether or not they are being attained.

Dilution. The addition of some quantity of less-concentrated liquid (water) that results in a decrease in the original concentration.

Direct runoff. Water that flows over the ground surface or through the ground directly into streams, rivers, and lakes.

Discharge. Flow of surface water in a stream or canal, or the outflow of groundwater from a flowing artesian well, ditch, or spring. Can also apply to discharge of liquid effluent from a facility or to chemical emissions into the air through designated venting mechanisms.

Discharge permits (under VPDES). A permit issued by the U.S. EPA or a state regulatory agency that sets specific limits on the type and amount of pollutants that a municipality or industry can discharge to a receiving water; it also includes a compliance schedule for achieving those limits. The permit process was established under the National Pollutant Discharge Elimination System, under provisions of the Federal Clean Water Act.

Domestic wastewater. Also called sanitary wastewater, consists of wastewater discharged from residences and from commercial, institutional, and similar facilities.

Drainage basin. A part of a land area enclosed by a topographic divide from which direct surface runoff from precipitation normally drains by gravity into a receiving water. Also referred to as a watershed, river basin, or hydrologic unit.

Effluent. Municipal sewage or industrial liquid waste (untreated, partially treated, or completely treated) that flows out of a treatment plant, septic system, pipe, etc.
Effluent limitation. Restrictions established by a state or EPA on quantities, rates, and concentrations in pollutant discharges.

Existing use. Use actually attained in the waterbody on or after November 28, 1975, whether or not it is included in the water quality standards (40 CFR 131.3).

GIS. Geographic Information System. A system of hardware, software, data, people, organizations and institutional arrangements for collecting, storing, analyzing and disseminating information about areas of the earth. (Dueker and Kjerne, 1989)

Hydrologic cycle. The circuit of water movement from the atmosphere to the earth and its return to the atmosphere through various stages or processes, such as precipitation, interception, runoff, infiltration, storage, evaporation, and transpiration.

Hydrology. The study of the distribution, properties, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere.

In situ. In place; in situ measurements consist of measurements of components or processes in a full-scale system or a field, rather than in a laboratory.

Margin of safety (MOS). A required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving waterbody (CWA section 303(d)(1)(C)). The MOS is normally incorporated into the conservative assumptions used to develop TMDLs (generally within the calculations or models) and approved by EPA either individually or in state/EPA agreements. If the MOS needs to be larger than that which is allowed through the conservative assumptions, additional MOS can be added as a separate component of the TMDL (in this case, quantitatively, a TMDL = LC = WLA + LA + MOS).

Mean. The sum of the values in a data set divided by the number of values in the data set.

MGD. Million gallons per day. A unit of water flow, whether discharge or withdraw.

Monitoring. Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, plants, and animals.

Narrative criteria. Nonquantitative guidelines that describe the desired water quality goals.

National Pollutant Discharge Elimination System (NPDES). The national program for issuing, modifying, revoking and re-issuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of the Clean Water Act.

Natural waters. Flowing water within a physical system that has developed without human intervention, in which natural processes continue to take place.

Non-point source. Pollution that originates from multiple sources over a relatively large area. Nonpoint sources can be divided into source activities related to either land or water use including failing septic tanks, improper animal-keeping practices, forest practices, and urban and rural runoff.

Numeric targets. A measurable value determined for the pollutant of concern, which, if achieved, is expected to result in the attainment of water quality standards in the listed waterbody.

Organic matter. The organic fraction that includes plant and animal residue at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population. Commonly determined as the amount of organic material contained in a soil or water sample.

Peak runoff. The highest value of the stage or discharge attained by a flood or storm event; also referred to as flood peak or peak discharge.

Permit. An authorization, license, or equivalent control document issued by EPA or an approved federal, state, or local agency to implement the requirements of an environmental regulation; e.g., a permit to operate a wastewater treatment plant or to operate a facility that may generate harmful emissions.

Point source. Pollutant loads discharged at a specific location from pipes, outfalls, and conveyance channels from either municipal wastewater treatment plants or industrial waste treatment facilities. Point sources can also include pollutant loads contributed by tributaries to the main receiving water stream or river.

Pollutant. Dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, Bacterial materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste discharged into water. (CWA section 502(6)).

Pollution. Generally, the presence of matter or energy whose nature, location, or quantity produces undesired environmental effects. Under the Clean Water Act, for example, the term is defined as the man-made or man-induced alteration of the physical, Bacterial, chemical, and radiological integrity of water.

Public comment period. The time allowed for the public to express its views and concerns regarding action by EPA or states (e.g., a Federal Register notice of a proposed rule-making, a public notice of a draft permit, or a Notice of Intent to Deny).

Raw sewage. Untreated municipal sewage.

Receiving waters. Creeks, streams, rivers, lakes, estuaries, ground-water formations, or other bodies of water into which surface water and/or treated or untreated waste are discharged, either naturally or in man-made systems.

Restoration. Return of an ecosystem to a close approximation of its presumed condition prior to disturbance.

Riparian areas. Areas bordering streams, lakes, rivers, and other watercourses. These areas have high water tables and support plants that require saturated soils during all or part of the year. Riparian areas include both wetland and upland zones.

Riparian zone. The border or banks of a stream. Although this term is sometimes used interchangeably with floodplain, the riparian zone is generally regarded as relatively narrow compared to a floodplain. The duration of flooding is generally much shorter, and the timing less predictable, in a riparian zone than in a river floodplain.

Runoff. That part of precipitation, snowmelt, or irrigation water that runs off the land into streams or other surface water. It can carry pollutants from the air and land into receiving waters.

Slope. The degree of inclination to the horizontal. Usually expressed as a ratio, such as 1:25 or 1 on 25, indicating one unit vertical rise in 25 units of horizontal distance, or in a decimal fraction (0.04), degrees (2 degrees 18 minutes), or percent (4 percent).

Stakeholder. Any person with a vested interest in assessment of natural condition or TMDL development.

Standard. In reference to water quality (e.g. pH 6 – 9 SU limit).

Storm runoff. Storm water runoff, snowmelt runoff, and surface runoff and drainage; rainfall that does not evaporate or infiltrate the ground because of impervious land surfaces or a soil infiltration rate lower than rainfall intensity, but instead flows onto adjacent land or into waterbodies or is routed into a drain or sewer system.

Streamflow. Discharge that occurs in a natural channel. Although the term "discharge" can be applied to the flow of a canal, the word "streamflow" uniquely describes the discharge in a surface stream course. The term "streamflow" is more general than "runoff" since streamflow may be applied to discharge whether or not it is affected by diversion or regulation.

Stream restoration. Various techniques used to replicate the hydrological, morphological, and ecological features that have been lost in a stream because of urbanization, farming, or other disturbance.

Surface area. The area of the surface of a waterbody; best measured by planimetry or the use of a geographic information system.

Surface runoff. Precipitation, snowmelt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of nonpoint source pollutants.

Surface water. All water naturally open to the atmosphere (rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors directly influenced by surface water.

Topography. The physical features of a geographic surface area including relative elevations and the positions of natural and man-made features.

Total Maximum Daily Load (TMDL). The sum of the individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources and natural background, plus a margin of safety (MOS). TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures that relate to a state's water quality standard.

Tributary. A lower order-stream compared to a receiving waterbody. "Tributary to" indicates the largest stream into which the reported stream or tributary flows.

Variance. A measure of the variability of a data set. The sum of the squared deviations (observation – mean) divided by (number of observations) – 1.

DCR. Department of Conservation and Recreation.

DEQ. Virginia Department of Environmental Quality.

VDH. Virginia Department of Health.

Wastewater. Usually refers to effluent from a sewage treatment plant. See also **Domestic wastewater**.

Wastewater treatment. Chemical, Bacterial, and mechanical procedures applied to an industrial or municipal discharge or to any other sources of contaminated water to remove, reduce, or neutralize contaminants.

Water quality. The Bacterial, chemical, and physical conditions of a waterbody. It is a measure of a waterbody's ability to support beneficial uses.

Water quality criteria. Elements of the board's water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use. When criteria are met, water quality will generally protect the designated use.

Water quality standard. Provisions of state or federal law which consist of a designated use or uses for the waters of the Commonwealth and water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law (§ 62.1-44.2 et seq. of the Code of Virginia) and the federal Clean Water Act (33 USC § 1251 et seq.).

Watershed. A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

Appendix C

CLASS VII RE-CLASSIFICATION LETTER TO USEPA USED IN LAST TRIENNIAL REVIEW

ATTACHMENT III – CLASS VII RE-CLASSIFICATION LETTER USED IN LAST TRIENNIAL REVIEW

October 14, 2003

MEMORANDUM

TO: EPA Region 3
FROM: David C. Whitehurst
SUBJECT: Supporting Data for Proposed Class VII (Swamp Waters) pH Criteria

As required by 40 CFR ?131.20, the purpose of this memo is to provide supporting data and information for Virginia's proposed classification change for several water bodies within the state. The Virginia Department of Environmental Quality (DEQ) has adopted a revised numerical pH criterion for some waters of the southeastern portion of the state as an effort to reflect the natural conditions of those waters and as an aid for the appropriate assessment of these waters. This criterion change is allowed according to 40 CFR ?131.11. (b). (1). (iii).

These waters were classified by the Virginia Water Quality Standards as Class III Coastal and Piedmont Nontidal Waters (9 VAC 25-260-50), with a pH range of 6.0 to 9.0 as is the case for all classes of waters statewide. The amendments to 9 VAC 25-260-5 define Class VII waters as "…waters with naturally occurring low pH and low dissolved oxygen caused by:
(1) low flow velocity that prevents mixing and re-aeration of stagnant, shallow waters and (2) decomposition of vegetation that lowers dissolved oxygen concentrations and causes tannic acids to color the water and lower the pH." The proposed pH criterion for Class VII waters is 4.3 to 9.0. The proposed amendments are a change in the numerical criterion for a particular type or class of water body and not an alteration of designated uses. Aquatic life uses shall be maintained and required effluent pH limits of 6.0 - 9.0 shall be maintained for all discharges to Class VII waters.

The water bodies that are proposed for Class VII designation are frequently referred to as blackwater streams/rivers due to the characteristic dark color that is a result of staining by fulvic and humic acids. The water chemistry is generally characterized by low buffering capacity and high acidity. The pH in peat draining blackwater systems can range from 3.5 - 6 and in mineral soil draining systems from 4 - 7. The naturally occurring acidic conditions of Mid-Atlantic Coastal Plain blackwater streams is well documented in peer reviewed scientific literature (Appendices A, B and G). The US Environmental Protection Agency 1997 publication “Field and laboratory methods for macroinvertebrate and habitat assessment of low gradient nontidal streams” states that "Coastal plain streams are often naturally acidic due to the high concentration of humic and fulvic acids found in the water draining swamp soils. The pH of these streams most often ranges from 3.5 to 7.5." (Appendix B)

Ambient water quality monitoring field pH data for stations within waters that are proposed as Class VII is presented in Appendix C as is a photo representative of the water body. Where sufficient data was available, pH values were averaged for each monitoring station on a water body and graphed. Individual pH values for each monitoring station were also graphed. The majority (> 50%) of individual pH values were below 7.

In an effort to confirm that point source discharges were not contributing to the low pH values, the DEQ permitting database was queried for pH violations (pH< 6) at permitted outfalls located on the proposed water bodies (Appendix D). One facility had two compliance violations (failure to report pH), one facility had three violations for discharge over the upper limit for pH (pH> 9), and one facility for effluent discharge less than the lower require limit (pH<6). All of the discharges are less than 1.0 MGD and the discharges are to small tributaries to the proposed Class VII waterbodies.

At the request of EPA Region 3 for DEQ to demonstrate that proposed Class VII waters are not impacted by acid rain that would unnaturally lower pH, daily precipitation data from the Virginia State Climatology Office was compared to DEQ ambient water quality monitoring field pH data (Appendix E). Daily rainfall data for 1996 - 2003 was filtered according to water sample collection dates at DEQ ambient water quality monitoring stations that are within an approximate 15-mile radius of precipitation monitoring stations. Precipitation amounts and field pH values were graphed together and correlation factors calculated. The only discernable pattern was a general negative correlation of precipitation to pH and the majority of r-values were well below 0.5, which does not indicate a close correlation between the variables.

According to an EPA web site (http://www.epa.gov/airmarkets/acidrain/index.html) the natural pH of rain is about 5.5 and the average pH of rainfall for the southeast/south-central region of Virginia, where the proposed Class VII waters are located, is 4.6 (Appendix F). Due to the naturally acidic conditions and low acid neutralizing capacity of the Virginia Coastal Plains watersheds, they are considered to be sensitive to atmospheric acid deposition (acid rain) and the effects may either be ameliorated or exacerbated by the type of land use in the watershed. A joint pilot study of episodic acidification of first order blackwater streams in southeastern Virginia conducted by Virginia Commonwealth University and DEQ found significant differences between pH depression duration and magnitude. Study sites within undisturbed old growth watersheds showed the greatest pH depressions and study sites within deforested and agricultural watersheds exhibited less severe pH depressions (Appendix G).

Other states such as North Carolina have narrative and numerical criteria in their water quality standards that recognize some waters may have characteristics outside of the "normal" range established by statewide standards (Appendix H). In light of this and other information presented here, it is logical and necessary that Virginia alter its numerical criterion for pH to reflect the naturally occurring conditions within certain water bodies in the state.

Attachments